PROCESSING-STRUCTURE-PROPERTY RELATIONSHIPS IN CELLULOSE NANOCRYSTAL/POLY(ETHLYENE-*CO*-VINYL ALCOHOL) COMPOSITES

Meisha L. Shofner, School of Materials Science and Engineering and Renewable Bioproducts Institute, Georgia Institute of Technology
meisha.shofner@mse.gatech.edu
Matthew P. Orr, School of Materials Science and Engineering and Renewable Bioproducts Institute, Georgia Institute of Technology

Key Words: cellulose nanocrystals, polymer processing, polarized optical microscopy, viscoelastic properties

Cellulose nanocrystals (CNCs) are nanoparticles of renewed interest in the composites community. Their abundance, renewable source material, and expected mechanical properties have motivated a large number of studies to understand how to use them effectively in composite applications. While these materials have desirable properties, they also present some challenges when considering them as a reinforcement for polymer composites. Specifically, they are not inherently compatible with most polymers, and they have a relatively low thermal decomposition temperature. Both of these factors inform the choice of suitable polymer matrices. The objective of this work is to explore possible materials selection and processing strategies for using them in nanocomposites. In this research, CNCs were paired with two different poly(ethylene-co-vinyl alcohol) (EVOH) polymers and processed using three complementary strategies to understand the processing-structure-property relationships of these materials. The different EVOH polymers had different amounts of the comonomers, ethylene and vinyl alcohol. Through these studies, it was observed that a combined solution and melt processing method produced materials with the highest levels of CNC dispersion and most favorable viscoelastic properties. Additionally, the matrix choice influenced the levels of dispersion observed. The CNCs would be expected to have a higher level of interaction with the EVOH polymer containing more vinyl alcohol, and the results indicated that this expectation was correct. The nanocomposite containing CNCs and the EVOH polymer containing more vinyl alcohol showed structuring of the matrix with CNC addition. These changes in dispersion and component interactions manifested themselves in the viscoelastic properties measured with dynamic mechanical analysis. Changes in the glass transition temperature and storage modulus below the glass transition temperature were observed. Overall, these results provide insight into how nanocomposite design parameters and processing strategies can be combined to produce improved properties, expanding the application space of CNC composites.